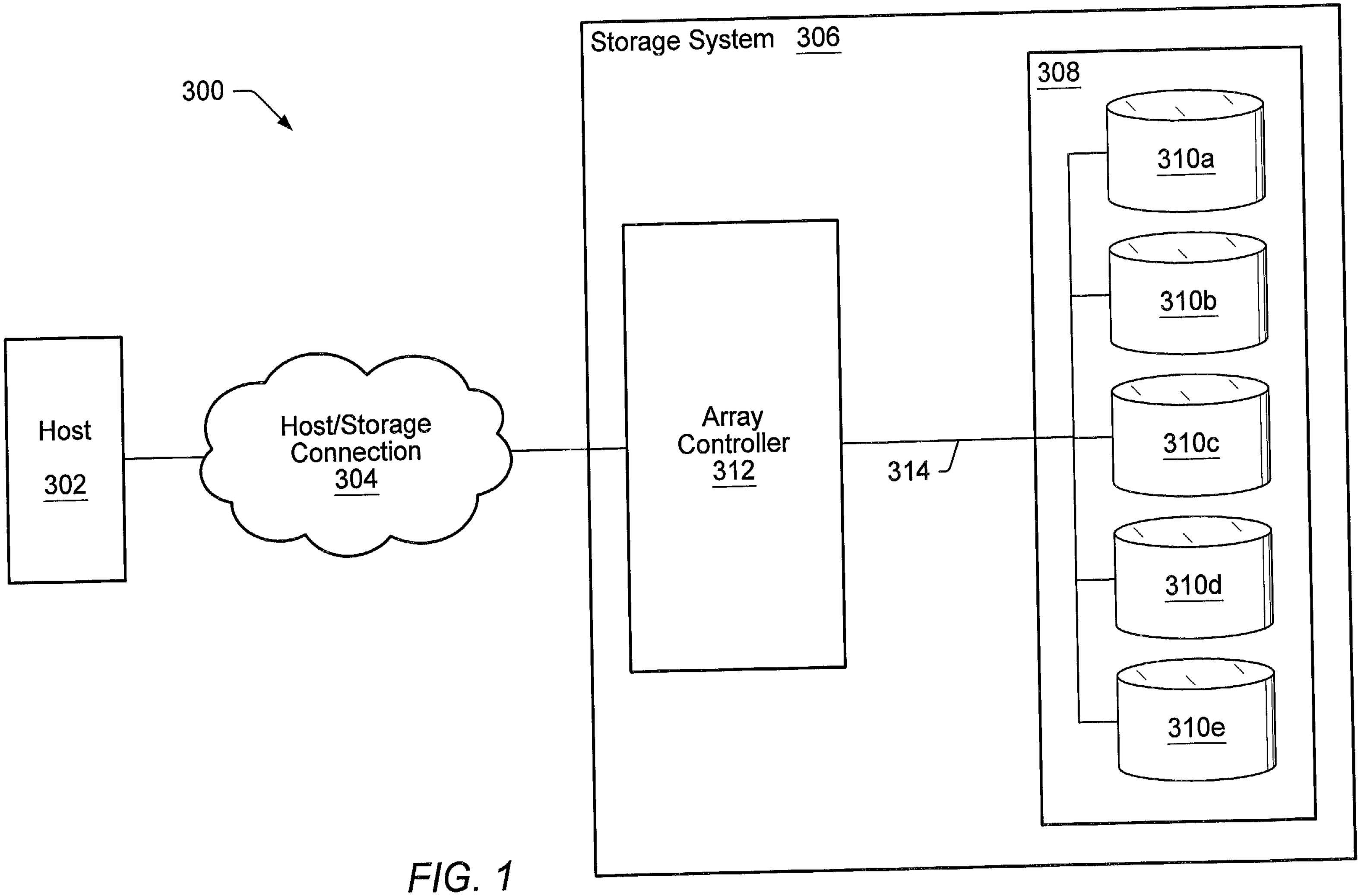

300
Host
302
Host/Storage
Connection
304
Storage System 306
Array
Controller
312
314
308
310a
310b
310c
310d
310e

FIG. 1

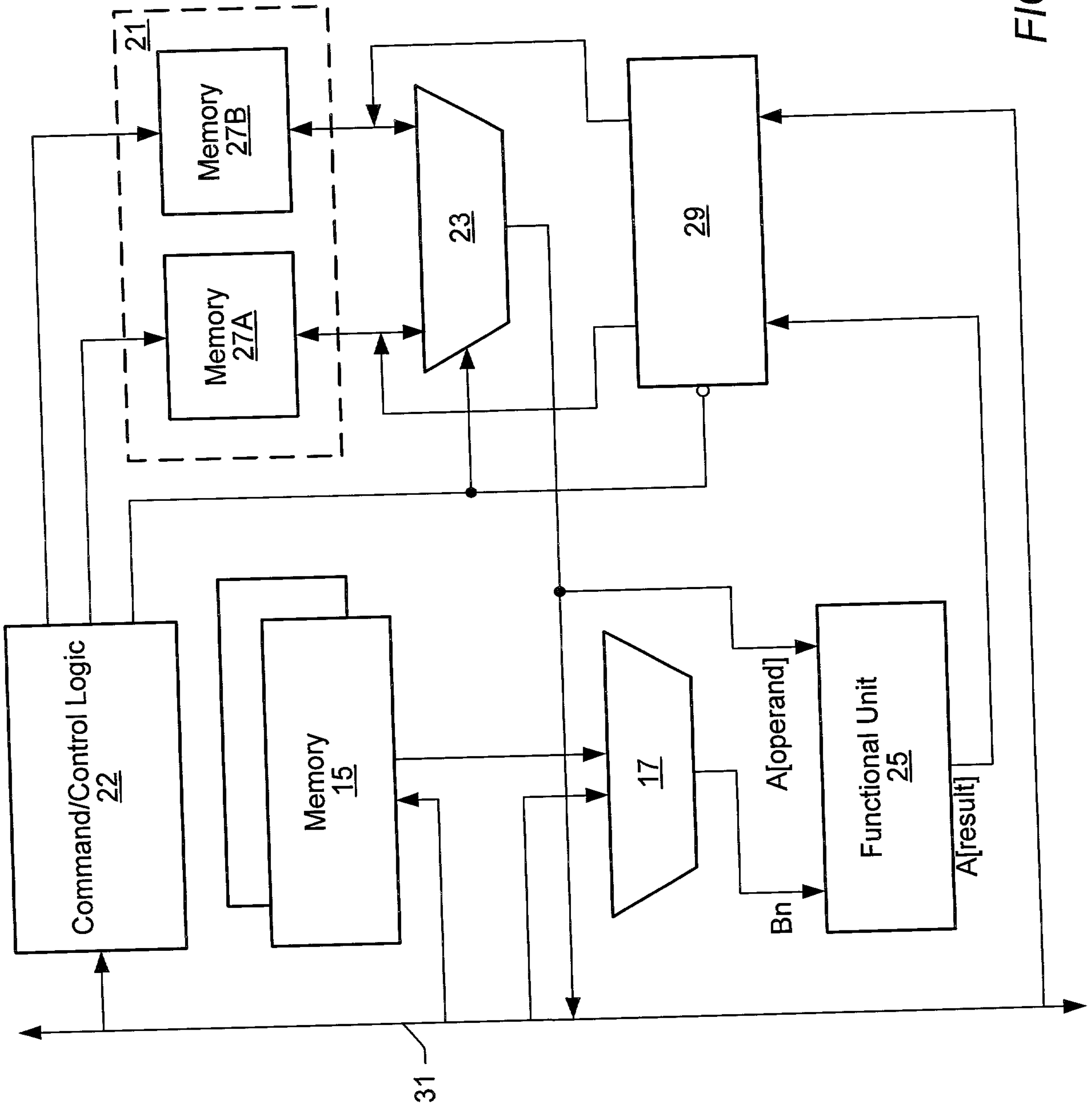

Command/Control Logic 22
Memory 15
17
A[operand]
Functional Unit 25
A[result]
Bn
21
Memory 27B
Memory 27A
23
29
31

FIG. 2

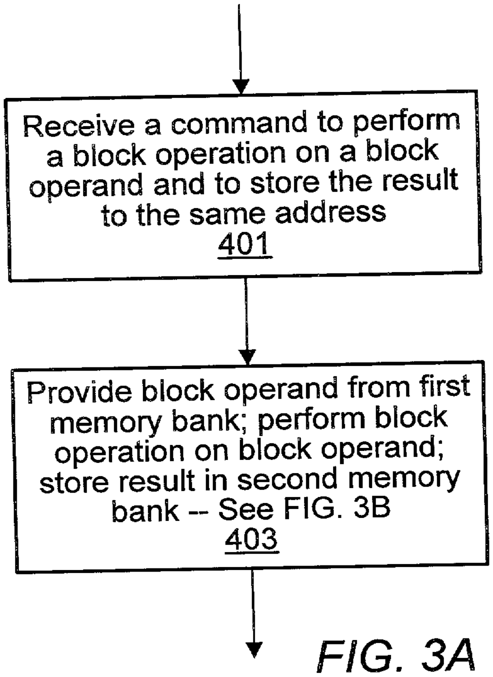

Receive a command to perform a block operation on a block operand and to store the result to the same address
401
Provide block operand from first memory bank; perform block operation on block operand; store result in second memory bank -- See FIG. 3B
403

FIG. 3A

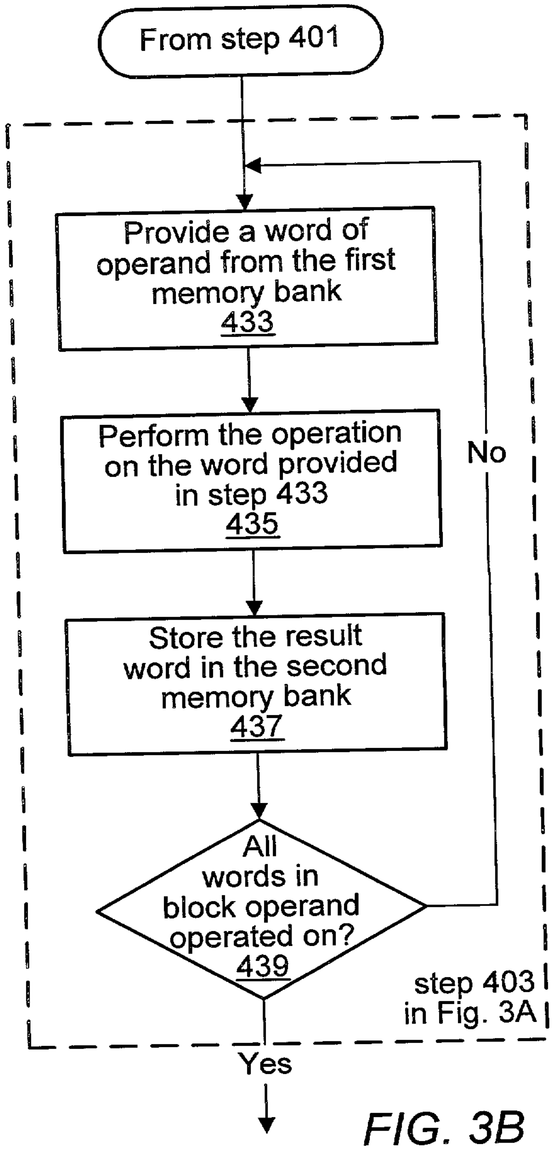

From step 401
Provide a word of operand from the first memory bank
433
Perform the operation on the word provided in step 433
435
Store the result word in the second memory bank
437
All words in block operand operated on?
439
No
Yes
step 403 in Fig. 3A

FIG. 3B

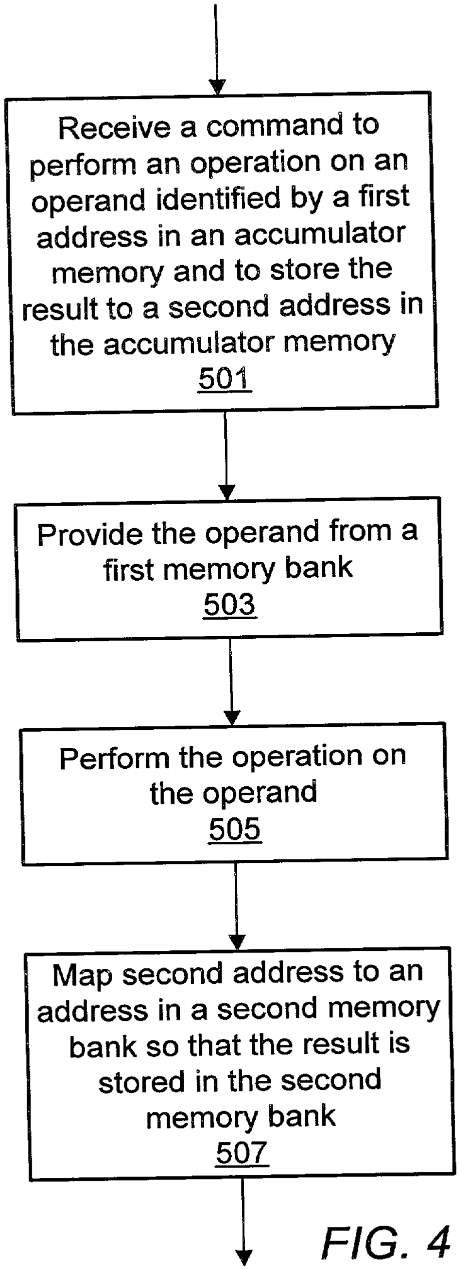

Receive a command to perform an operation on an operand identified by a first address in an accumulator memory and to store the result to a second address in the accumulator memory
501
Provide the operand from a first memory bank
503
Perform the operation on the operand
505
Map second address to an address in a second memory bank so that the result is stored in the second memory bank
507

FIG. 4

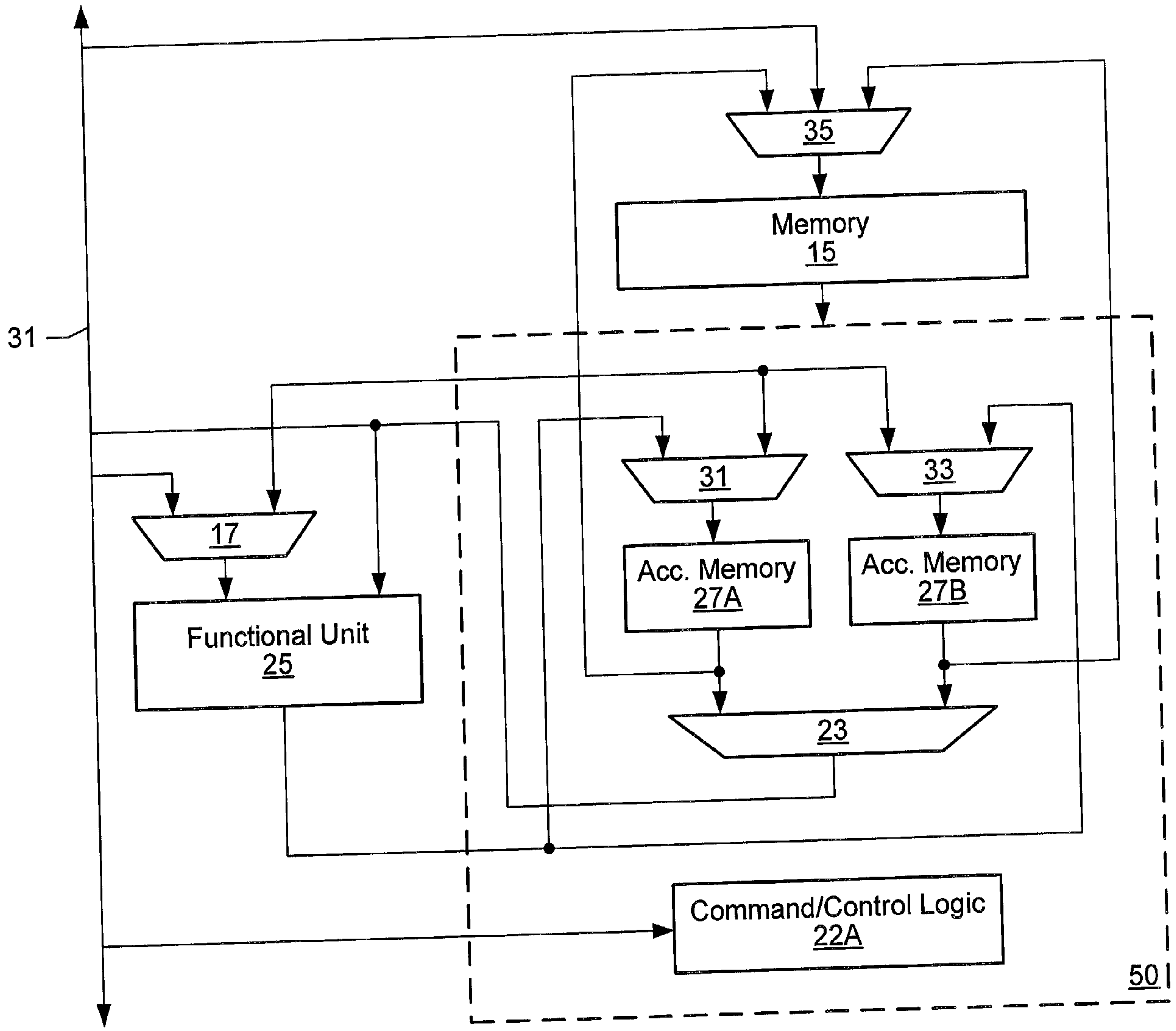

31
35
Memory
15
31
33
17
Acc. Memory
27A
Acc. Memory
27B
Functional Unit
25
23
Command/Control Logic
22A
50

FIG. 5

Instructions	Acc. Memory 27A	Acc. Memory 27B	Memory 15
B = B0	B(new)	n/a	B0
B = B XOR B1	B(old)	B(new)	B1
B = B XOR B2	B(new)	B(old)	B2
B = B XOR B3	B(old)	B(new)	B3
B = B XOR B4	B(new)	B(old)	B4
flush cache	n/a	n/a	B

FIG. 6

Instructions	Acc. Memory <u>27A</u>	Acc. Memory <u>27B</u>	Memory <u>15</u>
B = immed(B0)	B(new)	n/a	n/a
B = B XOR immed(B1)	B(old)	B(new)	n/a
B = B XOR immed(B2)	B(new)	B(old)	n/a
B = B XOR immed(B3)	B(old)	B(new)	n/a
B = B XOR immed(B4)	B(new)	B(old)	n/a
flush cache	n/a	n/a	B

FIG. 7

Accumulation Operations:

B = B0 XOR B1 XOR B2 XOR B3 XOR B4
C = C0 XOR C1 XOR C2 XOR C3 XOR C4
D = D0 XOR D1 XOR D2 XOR D3 XOR D4

Instructions:

(1) B = B0
(2) B = B XOR B1
(3) B = B XOR B2
(4) C = C0
(5) C = C XOR C1
(6) C = C XOR C2
(7) B = B XOR B3
(8) D = D0
(9) D = D XOR D1
(10) D = D XOR D2
(11) C = C XOR C3
(12) D = D XOR D3
(13) B = B XOR B4
(14) C = C XOR C4
(15) D = D XOR D4

FIG. 8A

Row#	Instructions/Operations	Acc. Memory 27A	Acc. Memory 27B	Memory 15
1	(1) B = B0	B(new)	n/a	B0
2	(2) B = B XOR B1	B(old)	B(new)	B1
3	(3) B = B XOR B2	B(new)	B(old)	B2
4	(4) C = C0	C(new)	n/a	C0
5	(5) C = C XOR C1	C(old)	C(new)	C1
6	(6) C = C XOR C2	C(new)	C(old)	C2
7	(7) B = B XOR B3	B(old)	B(new)	B3
8	(8) D = D0	n/a	n/a	n/a
9	(8) flush C	C	n/a	C
10	(8) load D	D(new)	n/a	D0
11	(9) D = D XOR D1	D(old)	D(new)	D1
12	(10) D = D XOR D2	D(new)	D(old)	D2
13	(11) C = C XOR C3	n/a	n/a	n/a
14	(11) flush B	n/a	B	B
15	(11) load C	n/a	C(new)	C
16	(11 completes)	C(new)	C(old)	C3
17	(12) D = D XOR D3	D(old)	D(new)	D3
18	(13) B = B XOR B4	n/a	n/a	n/a
19	(13) flush C	C	n/a	C
20	(13) load B	B(new)	n/a	B
21	(13 completes)	B(old)	B(new)	B4
22	flush B	n/a	B	B
23	(14) C = C XOR C4	n/a	n/a	n/a
24	(14) load C	n/a	C(new)	C
25	(14 completes)	C(new)	C(old)	C4
26	flush C	C	n/a	C
27	(15) D = D XOR D4	D(new)	D(old)	D4
28	flush cache	D	n/a	D

FIG. 8B

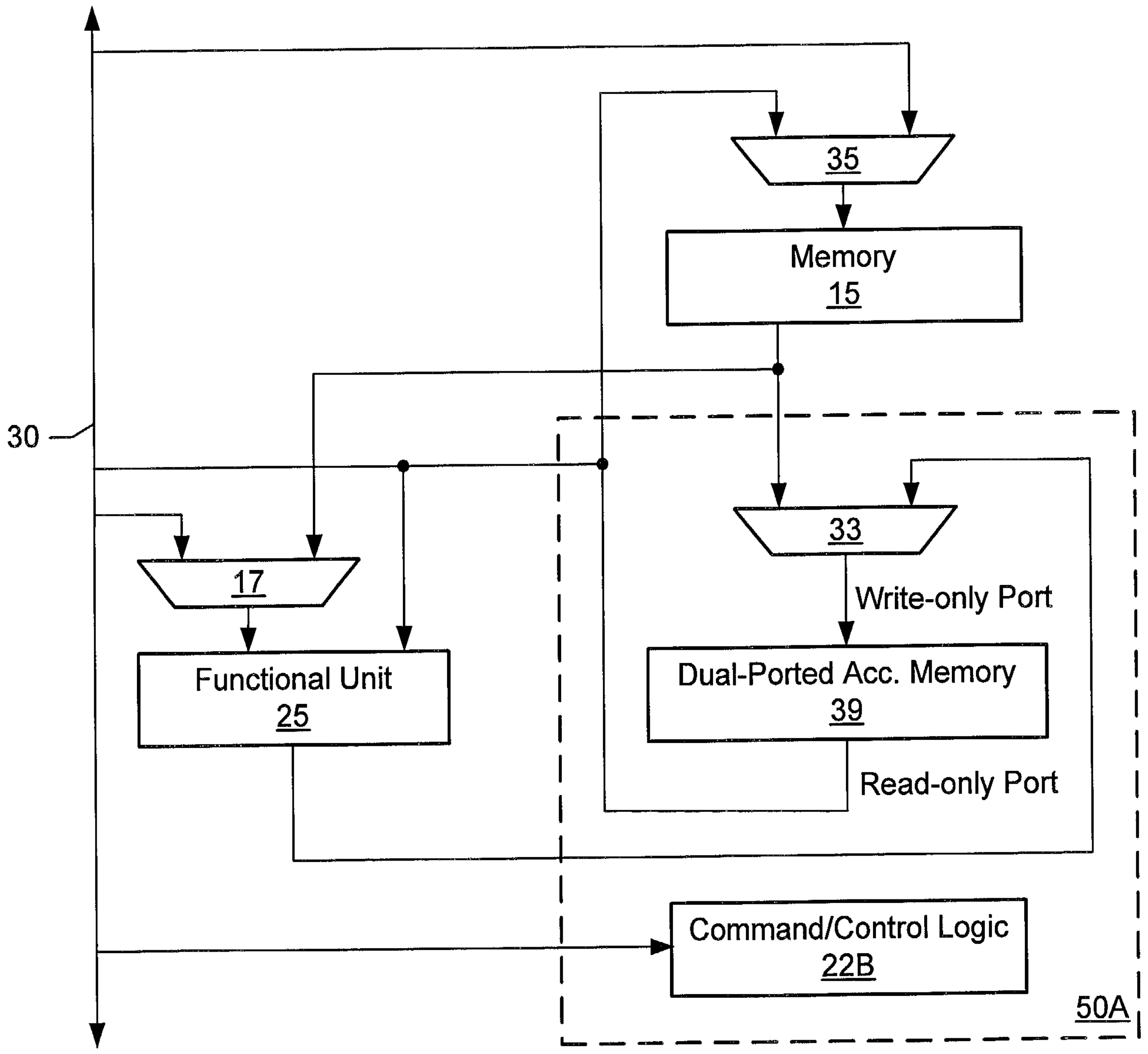

35
Memory
15
30
33
Write-only Port
17
Functional Unit
25
Dual-Ported Acc. Memory
39
Read-only Port
Command/Control Logic
22B
50A

FIG. 9

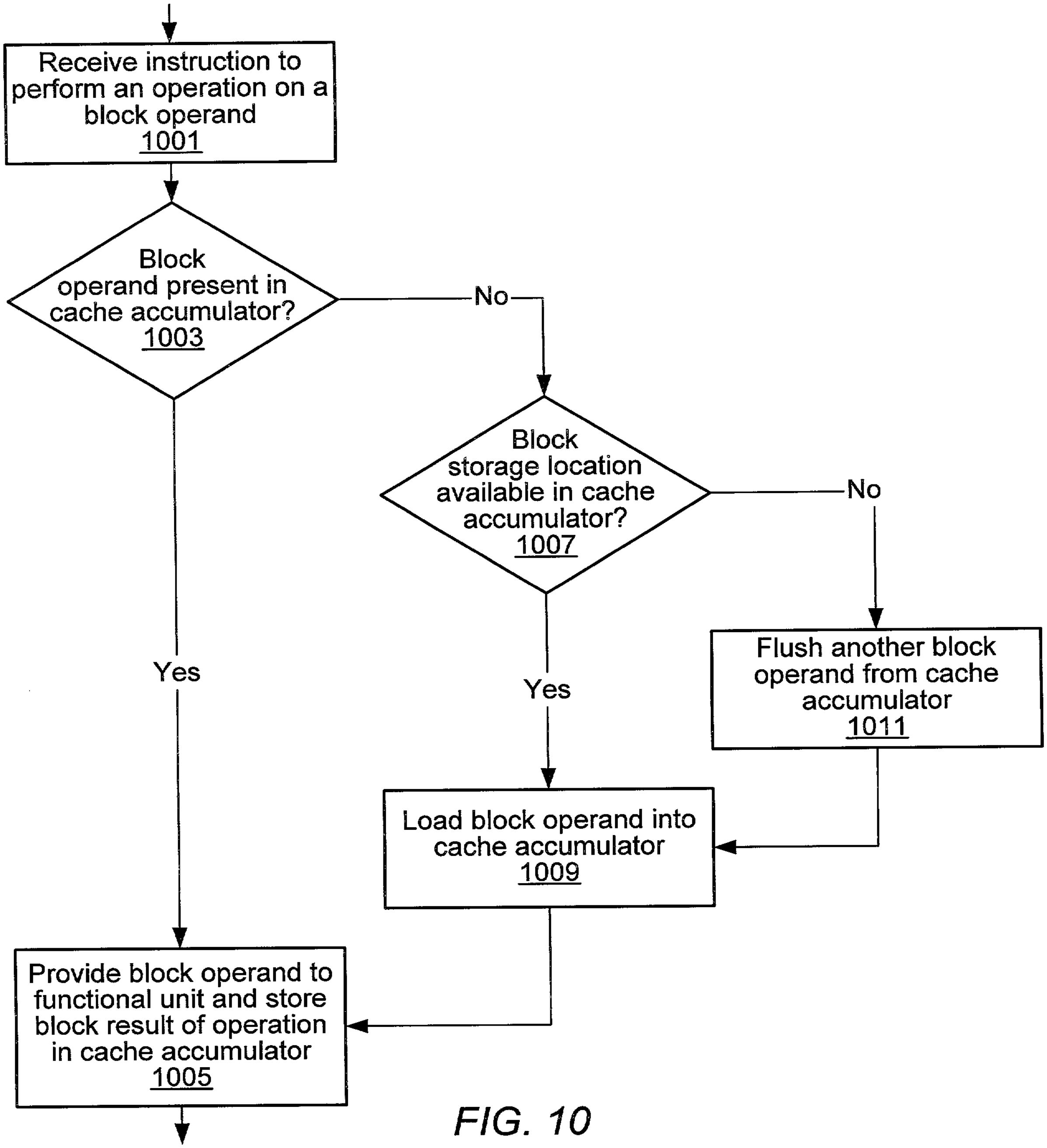

Receive instruction to perform an operation on a block operand
1001
Block operand present in cache accumulator?
1003
No
Yes
Block storage location available in cache accumulator?
1007
No
Yes
Flush another block operand from cache accumulator
1011
Load block operand into cache accumulator
1009
Provide block operand to functional unit and store block result of operation in cache accumulator
1005

FIG. 10

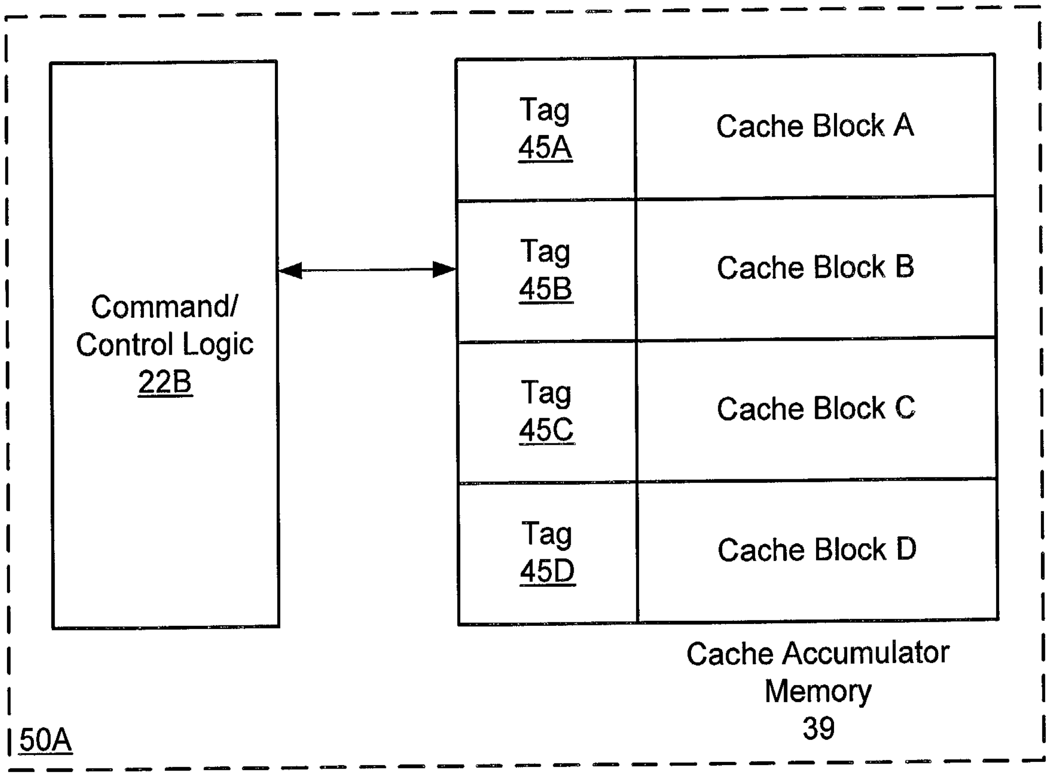


FIG. 11A

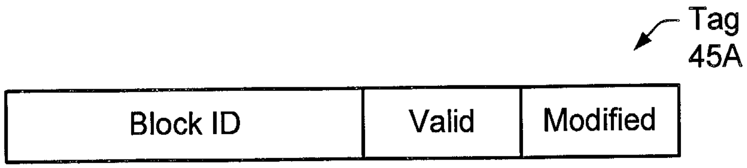


FIG. 11B

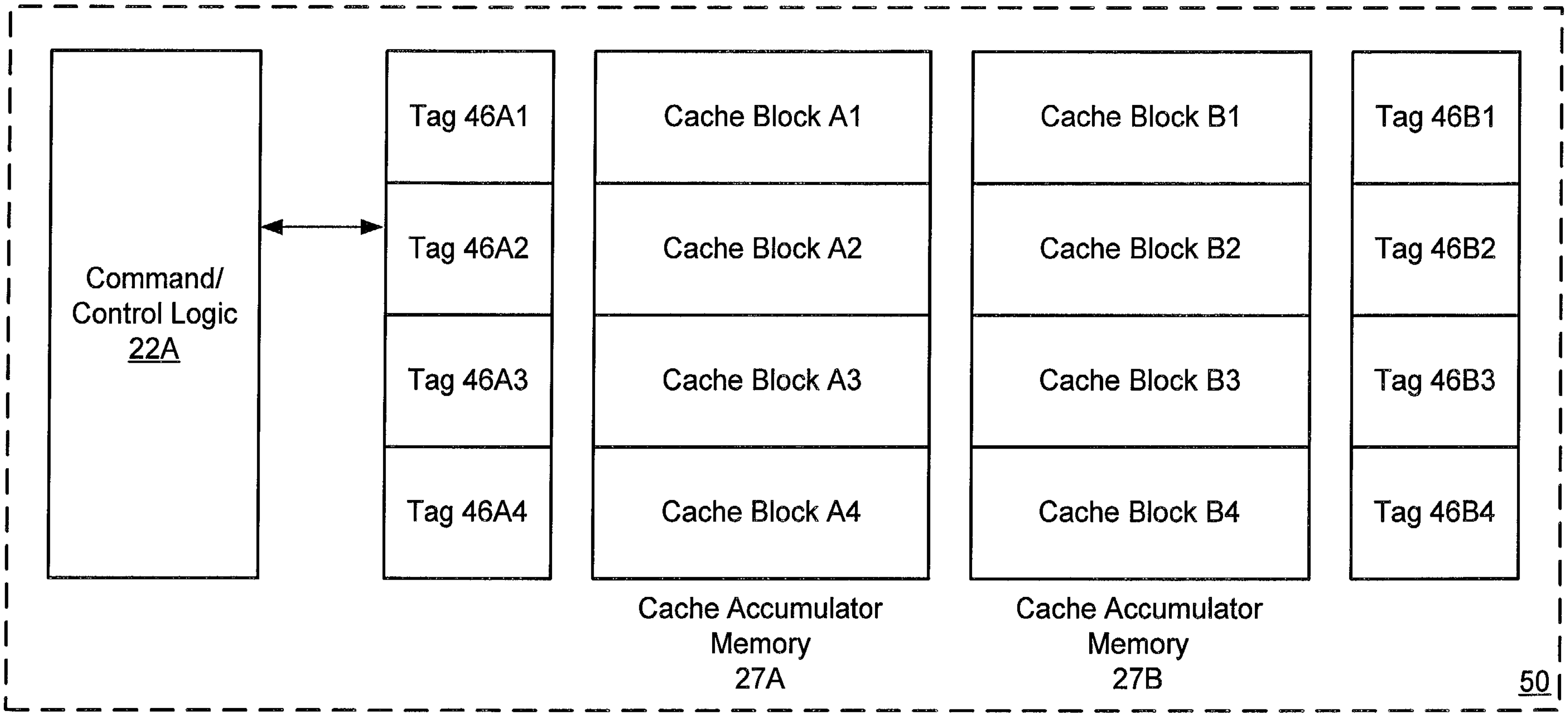


FIG. 12A

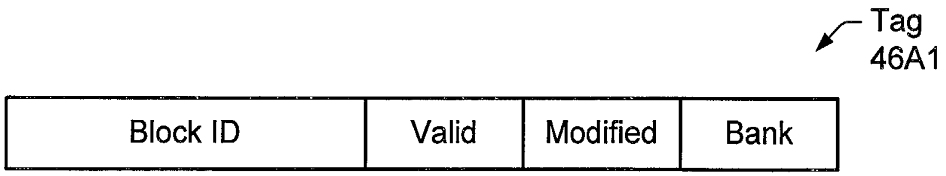
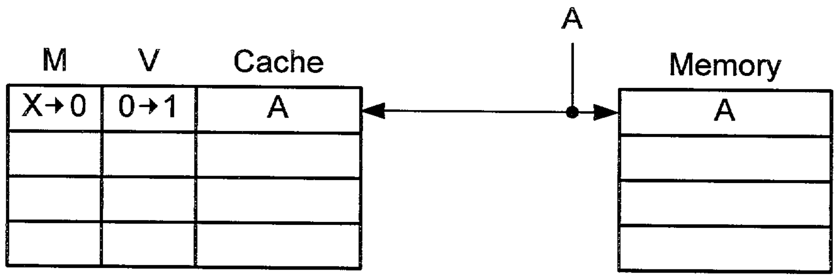


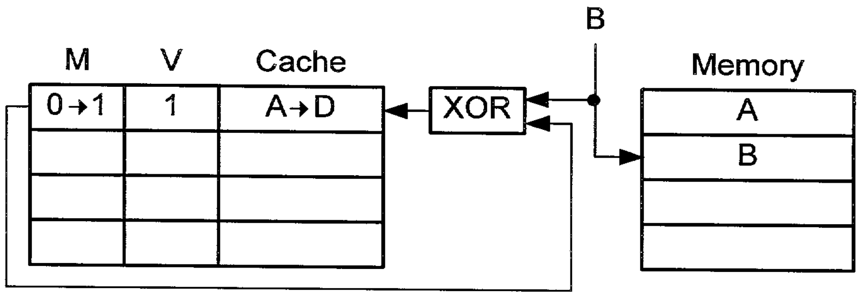
FIG. 12B

Accumulation Operation:
D = A XOR B XOR C



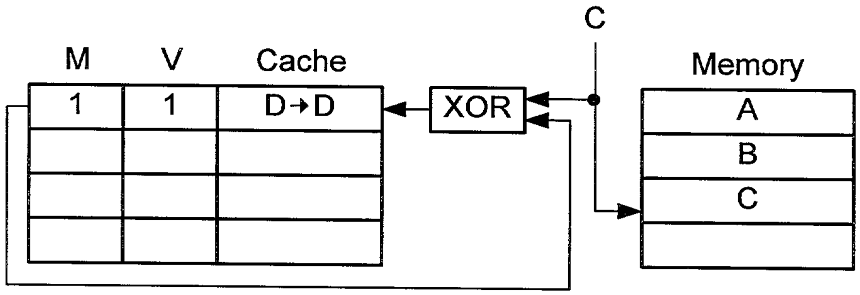
Instruction 1:
Write_Allocate(A)

FIG. 13A



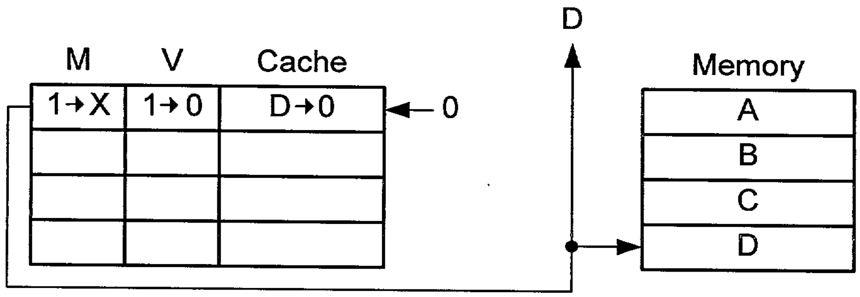
Instruction 2:
XOR_Write(A,B,D)

FIG. 13B



Instruction 3:
XOR_Write(D,C,D)

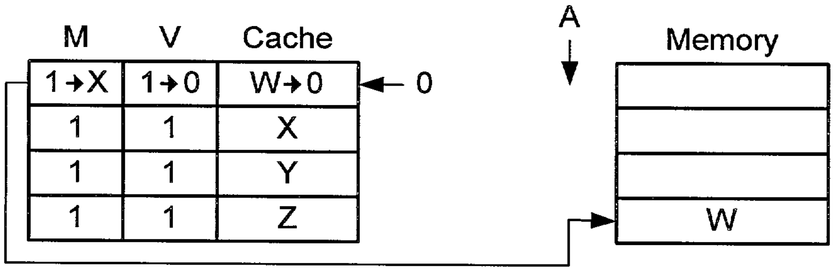
FIG. 13C



Instruction 4:
Read_Deallocate(D)

FIG. 13D

Accumulation Operation:
D = A XOR B XOR C



Instruction 1:
Write_Allocate(A)

All block storage locations are allocated; W is flushed to memory

FIG. 14A

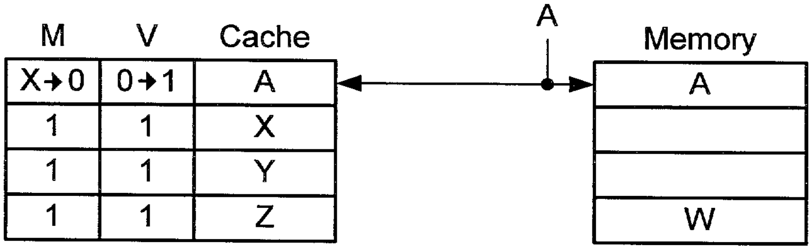
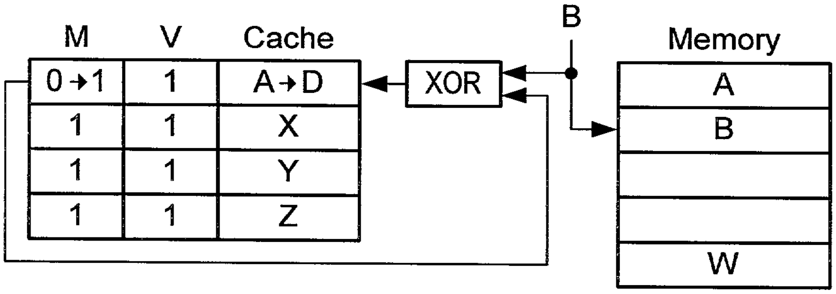
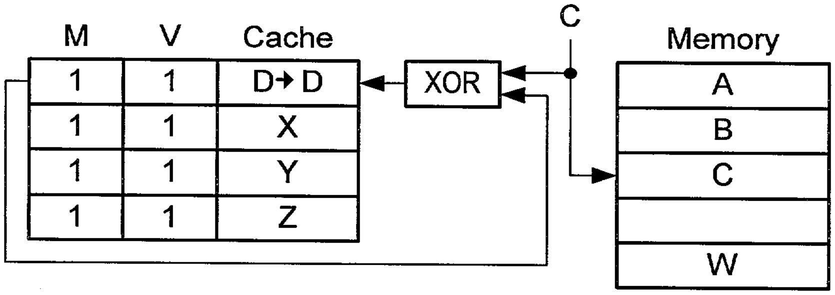


FIG. 14B



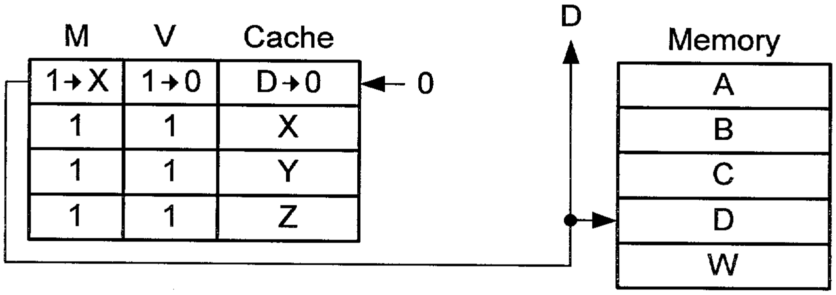
Instruction 2:
XOR_Write(A,B,D)

FIG. 14C



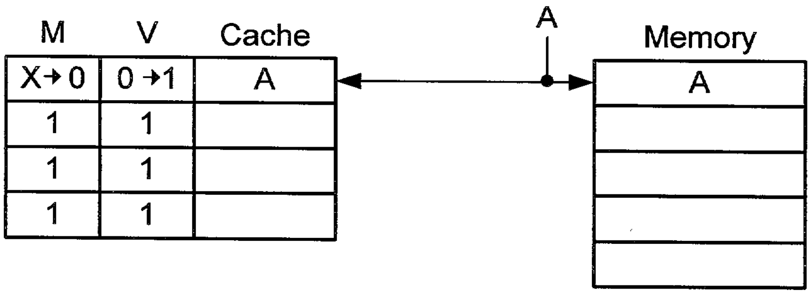
Instruction 3:
XOR_Write(D,C,D)

FIG. 14D



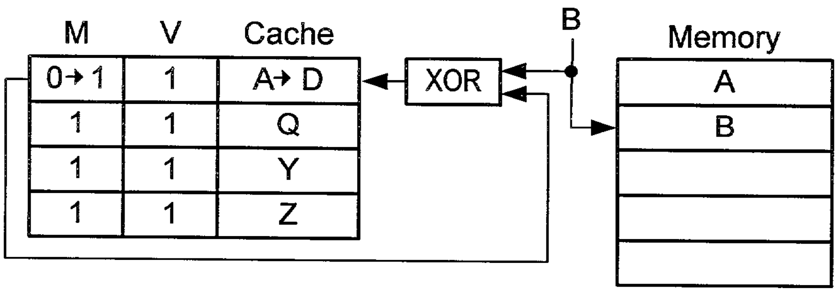
Instruction 4:
Read_Deallocate(D)

FIG. 14E



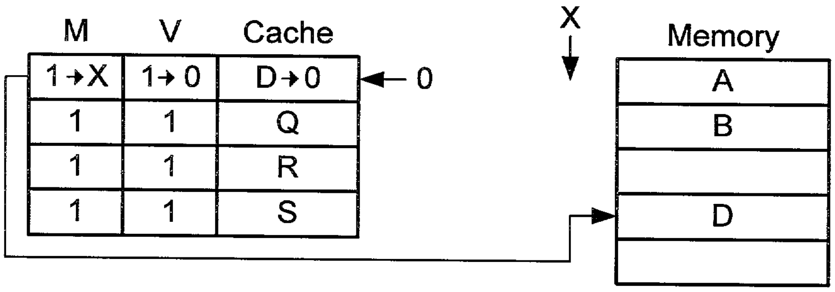
Instruction 1:
Write_Allocate(A)

FIG. 15A



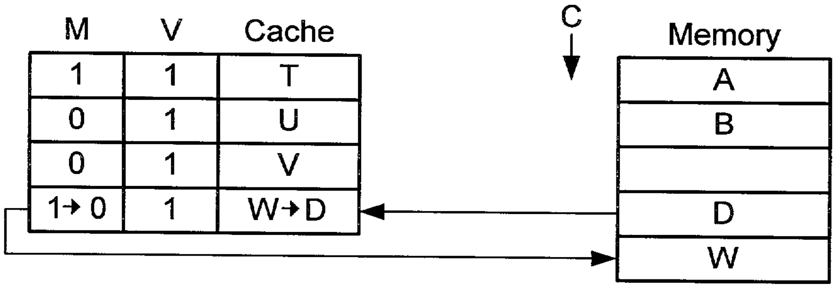
Instruction 2:
XOR_Write(A,B,D)

FIG. 15B



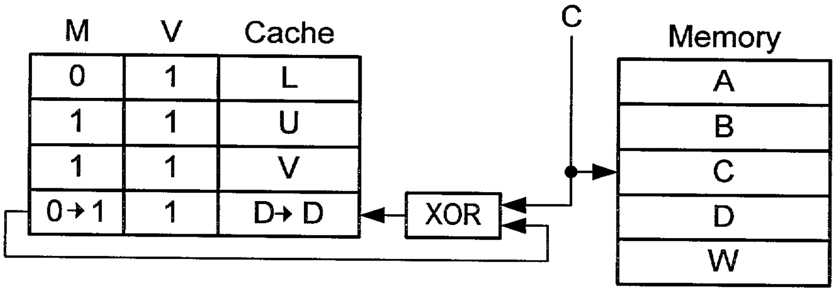
D is flushed to
memory.

FIG. 15C



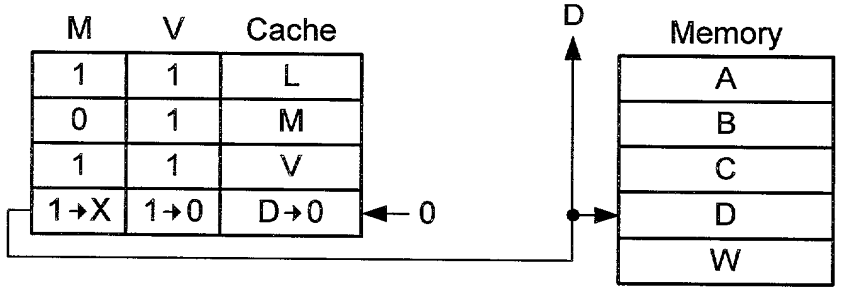
Instruction 3:
XOR_Write(D,C,D)

FIG. 15D



After D has been loaded into
the cache accumulator,
instruction 3 is executed.

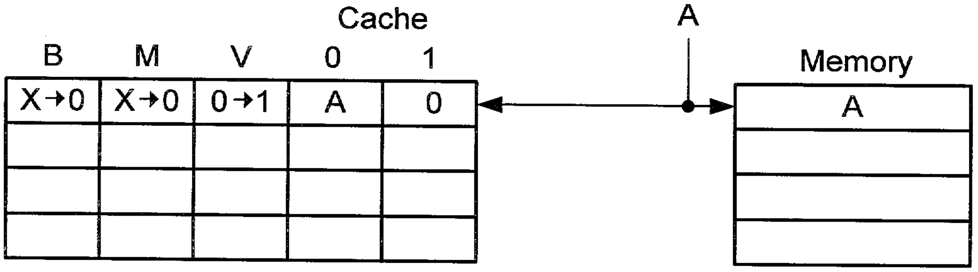
FIG. 15E



Instruction 4:
Read_Deallocate(D)

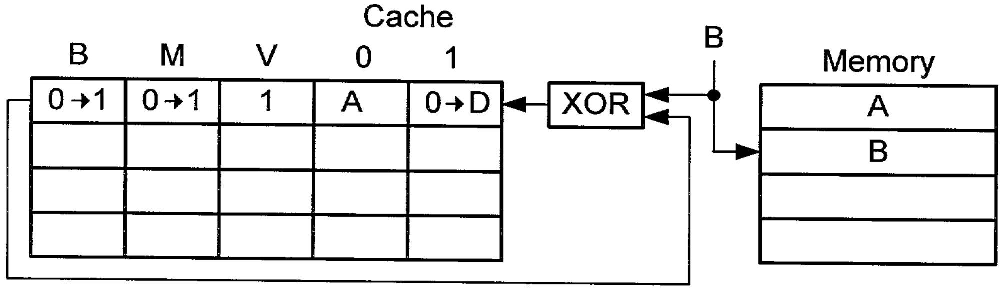
FIG. 15F

Accumulation Operation:
D = A XOR B XOR C



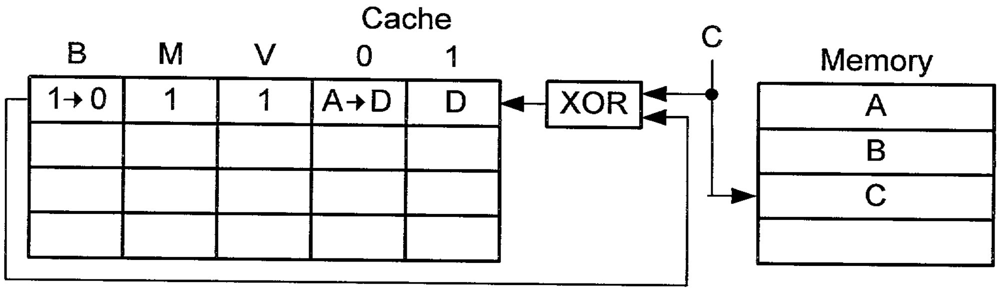
Instruction 1:
Write_Allocate(A)

FIG. 16A



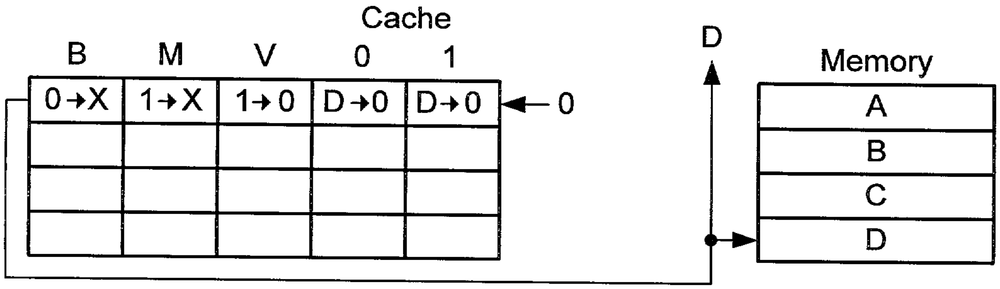
Instruction 2:
XOR_Write(A,B,D)

FIG. 16B



Instruction 3:
XOR_Write(D,C,D)

FIG. 16C



Instruction 4:
Read_Deallocate(D)

FIG. 16D

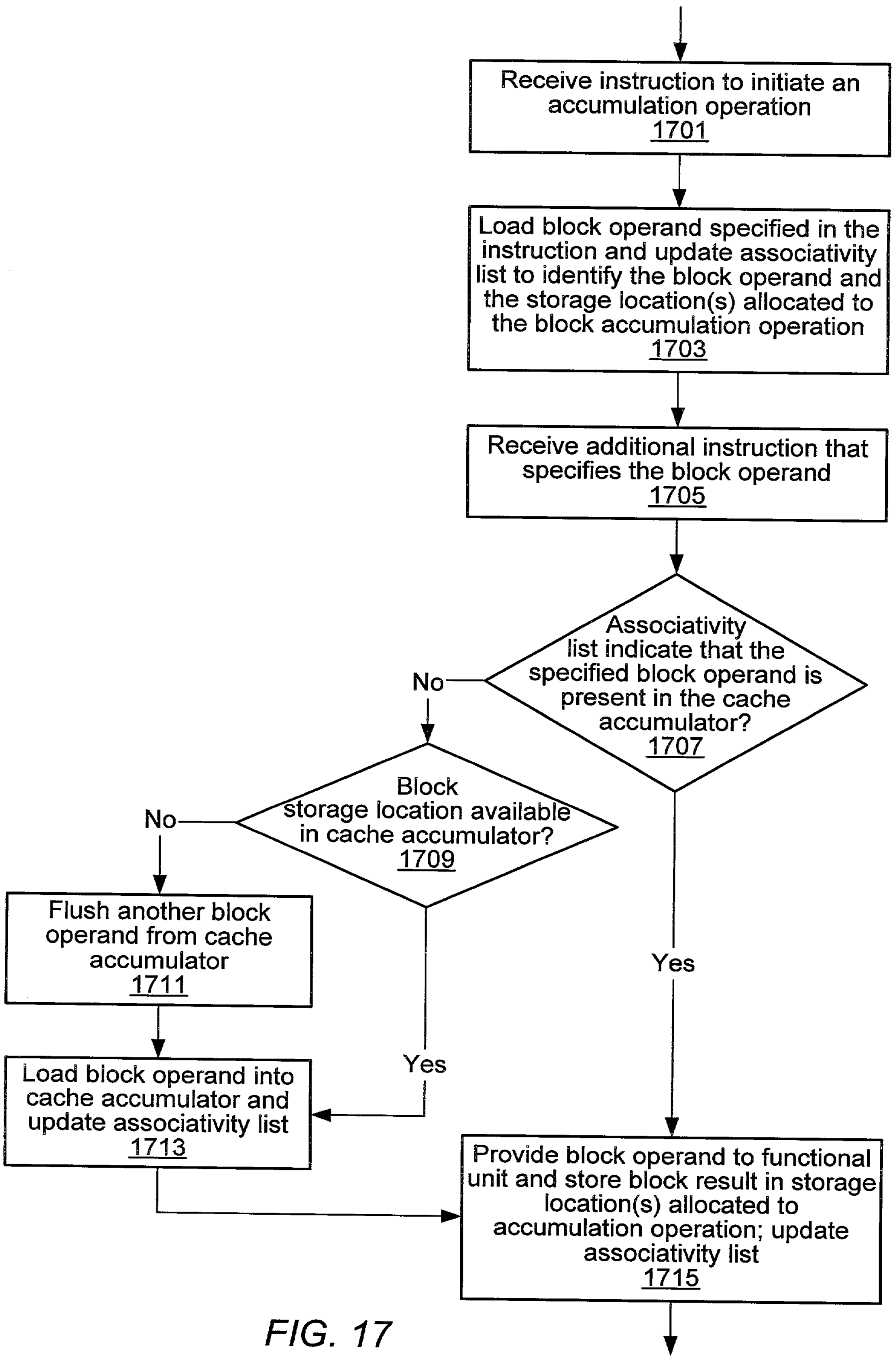

Receive instruction to initiate an accumulation operation
1701
Load block operand specified in the instruction and update associativity list to identify the block operand and the storage location(s) allocated to the block accumulation operation
1703
Receive additional instruction that specifies the block operand
1705
Associativity list indicate that the specified block operand is present in the cache accumulator?
1707
No
Yes
Block storage location available in cache accumulator?
1709
No
Yes
Flush another block operand from cache accumulator
1711
Load block operand into cache accumulator and update associativity list
1713
Provide block operand to functional unit and store block result in storage location(s) allocated to accumulation operation; update associativity list
1715

FIG. 17